

Original Research Article

Clinical and functional outcome of minimally invasive transforaminal lumbar interbody fusion in single segment lumbar spinal disease: a prospective observational study

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ABSTRACT

Background: Low back pain is the most common cause of work-related disability, which can be commonly caused by lumbar disc herniation, lumbar spinal stenosis, lumbar instability, and lumbar spondylolisthesis. Generally, treated conservatively, requiring surgical intervention when the effect of non-surgical management is poor or when symptoms of severe nerve damage occur. In the past decade, mainstream spinal surgery has been open surgery. Many studies have reported that minimally invasive TLIF provides equal or better results compared to open surgery. However there is very limited research on their clinical and functional outcome which is assessed in this study.

Methods: This was a prospective observational study conducted in a tertiary care hospital for one year. Patients who underwent MIS TLIF were assessed for clinical and functional outcome with ODI and VAS score pre operative and post operative at one year. Blood loss and surgical duration was also calculated. Patients aged 20-55 with lower back pain and /or neurogenic deficit that originated from single level lumbar degenerative disease were included. Those with new or old spinal fractures, previous spinal surgery and patients with medical condition requiring intensive medical therapy were excluded.

Results: The mean pre-operative VAS score was 7.64 ± 0.95 , which significantly decreased to 2.28 ± 0.89 post-operatively, with a p-value of 0.000, indicating a statistically significant reduction in pain levels. Similarly, mean pre-operative ODI was 68.72 ± 6.63 , which decreased to $19.3.0 \pm 2.82$ post-operatively, with a p value of 0.000, demonstrating significant improvement.

Conclusions: Our results suggest that MIS TLIF procedure has good clinical and functional outcome (p value <0.05) in terms of ODI and VAS Score and thus can be considered an ideal advancement in surgical procedure.

Keywords: Fusion, Minimally invasive spine, MIS-TLIF, Transforaminal

INTRODUCTION

The most frequent reason for a work-related impairment is lumbago. Activity exacerbates, which ultimately results in activity avoidance and hence impairment. A person's lifetime risk of developing low back pain is between 50 and 70 percent.¹ Pain lasting less than six weeks is classified as acute non-specific low back pain; pain lasting between six weeks and three months is classified as

subacute pain; and pain lasting longer than three months is classified as chronic pain.² Lumbar spinal instability is defined as the appearance of deformity or discomfort along with a loss of the spine's ability to maintain the connections between the vertebrae required to prevent injury to the spinal cord or irritation of the nerve roots. Instability is considered to exist when there is a differential of 4 mm in translation or 10 degrees in sagittal rotation from the following level.

Conservative treatment is typically used for lumbar degenerative diseases; however, surgery may be necessary if non-surgical treatment is ineffective or if symptoms of significant nerve damage manifest for which open surgery has been the standard for spinal surgery for the past few decades.³

Out of the surgical options available, fusion is commonly done to achieve stable fusion of spinal segments with good vertebral height and alignment.⁴⁻⁷ Traditional midline transforaminal lumbar interbody fusion (TLIF) is considered a classic surgery.^{8,9} The disadvantage of this procedure being increased risk of muscle atrophy and denervation and "fusion disease".¹⁰⁻¹² With advancing technology, this procedure can now be done MIS, this offers results comparable to other fusion methods.^{13,19-22} The benefits include less discomfort and hence earlier return to routine.¹⁴⁻¹⁸

However, there is very limited research on comparing the clinical and functional outcome of MIS-TLIF which was done in this study in the form of Oswestry disability index (ODI) and visual analog scale (VAS) score in single segment lumbar spinal disease.

METHODS

This was a prospective observational study done for patients who underwent fluoroscopy image guided MIS TLIF surgery over a period of one year (October-2023-September 2023) in a tertiary care orthopaedic-spine unit (Dr Sampurnanand Medical College and Hospital) were assessed for clinical and functional outcome with ODI and VAS score pre operative and post operative with calculated sample size of 25. The study was commenced after obtaining Institutional Ethics Committee approval (IEC/SNMC/2023/768). Blood loss, surgical duration was also calculated.

Patients aged 20-55 with lower back pain and /or neurogenic deficit that originated from single level lumbar degenerative disease were included. New or old spinal fractures, previous spinal surgery and medical condition requiring intensive medical therapy were excluded.

Radiographs, MRI, surgical time, blood loss and complications were noted. Microsoft Excel and SPSS version 26.0 were used for data cleaning and statistical analysis. Categorical and continuous variables were reported in proportions and mean $\pm$ standard deviation (SD). A paired sample t-test was used to assess and determine whether there was a mean difference between the two sets of observations. The statistical significance was determined at a 5% level.

RESULTS

Total of 25 patients were enrolled with the mean age of 47.60 ± 4.62 years. 40% of the participants were within the 35-45 years range, while the majority, 60%, are in the 46-

55 years range. 56% of the participants were males, and 44% were females.

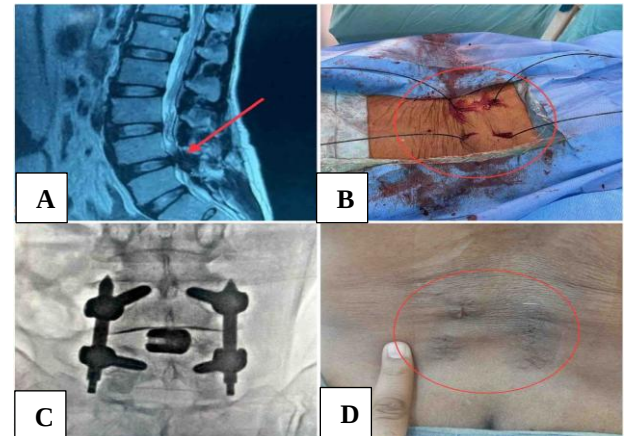


Figure 1: Case example; (A) preoperative Sagittal section MRI, (B) intraoperative image showing pedicle screw guides inserted, (C) post operative anteroposterior view radiographs and (D) post operative scar.

Table 1: Age comparison.

Age (in years)	Number of patients	Percentage
35-45	6	24
45-55	19	76
Total	25	100

Table 2: Gender distribution.

Gender	Number of patients	Percentage
Male	14	56
Female	11	44
Total	25	100

Table 3: Diagnosis.

Diagnosis	Number of patients	Percentage
Spondylolisthesis	15	60
Lumbar canal stenosis	10	40

60% of the participants were diagnosed with Spondylolisthesis, while 40% were diagnosed with lumbar canal stenosis. When examining the affected spinal levels, the L4-L5 level was the most commonly affected, with 60% of participants experiencing issues at this level. The L3-L4 level was affected in 24% of participants and the L5-S1 level was affected in 16% of participants.

The mean OT duration is 1.8 ± 0.34 hours, indicating the average time spent in the OT. When categorized by OT duration, 24% of the participants had an OT duration of 1-1.5 hours. The most common duration range was 1.6-2 hours, with 44% of participants falling into this category.

Additionally, 32% of participants experienced an OT duration of 2-3 hours.

Table 4: Level affected.

Level	Number of patients	Percentage
L3-L4	6	24
L4-L5	15	60
L5-S1	4	14
Total	25	100

Table 5: OT time.

OT Time (hrs)	Number of patients	Percentage
1-1.5	5	20
1.5-2	11	44
2-2.5	9	36
Total	25	100

The mean blood loss is 164.80 ± 23.11 ml, reflecting the average amount of blood lost during procedures. When categorized by blood loss amount, 36% of the participants experienced blood loss between 130-150 ml. Blood loss in the range of 151-170 ml was observed in 32% of participants. Additionally, 16% of participants had blood loss between 171-190 ml, and another 16% experienced blood loss between 191-210 ml.

Pre-operatively, the ODI values ranged from 56 to 84, with 4% of participants having ODI values of 56, 60, 78, 82, and 84 each. ODI values of 62 and 72 were observed in 8% of participants each, while ODI values of 64 and 70 were seen in 12% of participants each. ODI values of 66 and 68 were the most common, each observed in 16% of participants. Post-operatively, the ODI values ranged from 16 to 24, with 20% of participants each having ODI values of 16 and 18. ODI values of 20 and 24 were observed in 16% of participants each, and the most common post-operative ODI value was 22, seen in 28% of participants.

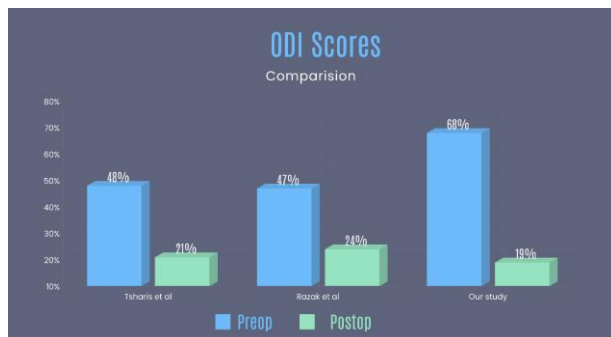


Figure 2: ODI score comparison.

For the VAS scores, pre-operatively, scores ranged from 6 to 9, with 8% of participants scoring 6, 44% scoring 7, and 24% scoring 8 or 9. Post-operatively, VAS scores ranged from 1 to 4, with 20% of participants scoring 1, 40% scoring 2, 32% scoring 3, and 8% scoring 4.

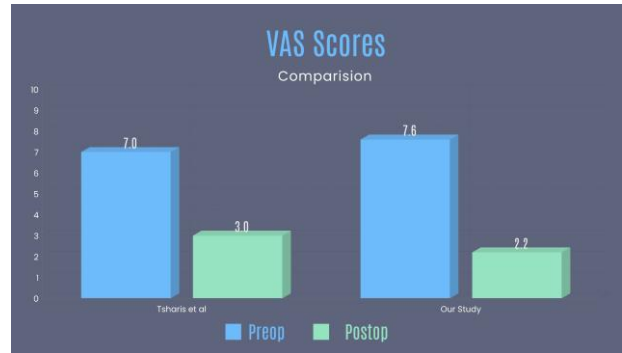


Figure 3: VAS score comparison.

The VAS scores and ODI values pre- and post-operation is compared; highlighting significant improvements post-surgery. The mean pre-operative VAS score was 7.64 ± 0.95 , which significantly decreased to 2.28 ± 0.89 post-operatively, with a p value of 0.000, indicating a statistically significant reduction in pain levels. Similarly, the mean pre-operative ODI was 68.72 ± 6.63 , which substantially decreased to 19.30 ± 2.82 post-operatively, also with a p value of 0.000, demonstrating a highly significant improvement in ODI.

DISCUSSION

Most research in the past has focused on perioperative complications; however, more recent studies have moved their attention to long-term outcomes, particularly long-term clinical outcomes and the unavoidable occurrence of difficulties after fusion surgery.²³ Since Cloward originally detailed posterior lumbar interbody fusion in 1952, the technique has undergone significant development.²⁴

Transforaminal lumbar interbody fusion results in decompression of both the neural foramen and the spinal canal. It reestablishes the sagittal equilibrium using a wholly posterior approach preserving the posterior soft tissues that envelop the dural sac are preserved with MIS TLIF.

The open transforaminal lumbar interbody fusion (TLIF), which was first described by Harms and Rolinger in 1982, has since grown to be one of the most successful lumbar spine fusion techniques.²⁵ Foley and Lefkowitz established the minimally invasive variation (MIS-TLIF) in the early 2000s with the introduction of minimally invasive spine surgery (MISS).²⁶

The MIS-TLIF has shown less difficulties since it was introduced. Moreover, MIS-TLIF has been linked to positive results in individuals who are obese.²⁷

Because of this, MIS-TLIF has gained popularity and produced outcomes that are on par with those of open TLIF or traditional PLIF.²³

The following are the fundamental ideas that explain why MIS-TLIF is superior to open TLIF: In order to achieve the surgical goal, the following three goals must be met: (1) minimizing soft tissue disruption and destabilization of the spinal segment(s); (2) accomplishing bilateral decompression when a unilateral approach is required; and (3) accomplishing indirect neural decompression.²⁸

There have been other studies published in international journals about MIS TLIF vs Open TLIF procedure, but there are only a handful of articles where ODI and VAS score was used to assess clinical outcome after MIS TLIF, comparison of which has been depicted in the table.

Tsharis et al have published their work in 2012 in the European Spine Journal comparing the preoperative and postoperative ODI score in patients who underwent MIS TLIF in single segment lumbar spinal diseases.²⁹ It was a prospective analysis of 34 consecutive patients where ODI scores were recorded pre-operatively and at 6-month follow up. They concluded that MIS-TLIF has significant outcome in treatment of lumbar degenerative spine diseases.

Razak et al assessed outcomes of 56 patients treated by a single surgeon, where postoperative scores improved relative to preoperative scores, and this was sustained across various time points for up to 5 years ($p < 0.001$).³⁰ This was a long term study. Our experience with the MIS-TLIF procedure confirms the findings of prior studies in that MIS TLIF produces significant (p value < 0.05) clinical and functional outcome as per the ODI scores that we have used for calculation, this outcome was similar to studies by Tsharis et al, Razak et al with significant outcome in terms of our secondary objectives operation time, blood loss, duration of surgery as well.^{29,30}

We can see the significant improvement in ODI and VAS scores. Tsharis et al have not used VAS scores in their study as shown in the figures.²⁹

Drawbacks of this study are the lack of a comparative study group, short follow-up and smaller data size. Theoretically, with such short duration of follow up, we cannot effectively compare the results but our analysis is fairly comparable with the results of previous studies.

CONCLUSION

MIS - TLIF is a safe and efficacious technique for single segment lumbar degenerative disease with excellent outcome in terms of ODI and VAS scores as evident from this study and similar studies done elsewhere.

With the added advantages it offers of minimal incision and less blood loss, this surgical procedure requires further research in terms of long-term outcome and radiation exposure.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee (IEC/SNMC/2023/768)

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